POSTLARVAL STAGES OF AUSTRALIAN FISHES.—NO. 1. [4]

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(Text-figures 1-8.)

It has been the good fortune of the writer to obtain, whilst netting in the estuaries of southern Queensland and New South Wales, many interesting larval and postlarval stages of fishes. In most instances these very young stages differ considerably from the adults of the same species both in proportions and coloration. They present more than the usual difficulties in their specific identification. Descriptions of juvenile stages of even the commoner Australian fishes have never featured to any extent in ichthyological publications. It is the object of this series of articles to outline the principal characteristics of hitherto undescribed early developmental stages of many of our commercial and better known species.

As most of the postlarvae featuring in the following descriptions are less than twenty millimetres in length, special gear had to be employed for collecting. Plankton tow nets were useful for the capture of the smaller pelagic larvae and postlarvae. The bulk of the collecting was carried out by means of a special small meshed hauling seine net designed by the writer for the specific task of capturing fish fry sheltering in *Zostera* weed beds of shallow creeks and mud flats, and in the sandy shallows near river mouths. This net was shot by wading it around at low tide. Its length was 25 yards and the depth four feet. The bunt was of 7 millimetre square meshed French netting with an innermost section and pocket of 4 millimetre square mesh. The wing sections, each of 10 yards, were of $\frac{1}{8}$ inch prawn netting. This type of net was found to be most successful for this particular purpose.

Acknowledgment is due to Mr. G. L. Kesteven, who made available a quantity of unsorted plankton from the Noosa River collected in June 1940. This is supplementary to the writer's own extensive monthly plankton collections during the years 1944 and 1945.

1. ACANTHOPAGRUS AUSTRALIS (Günther). AUSTRALIAN BREAM.

Chrysophrys australis Günther (1859), p. 494.

A detailed description of the eggs and early larvae of the Australian Bream has already been published by Tosh (1903). Kesteven and Serventy (1941) have shown that this species spawns near the mouths of southern Queensland rivers. It may be added that the main spawning begins with the Sea Bream runs of May and June but sometimes occurs earlier and appears to continue throughout the winter months. The eggs are pelagic and are spawned at night on a flooding tide when the moon is full. The larvae are planktonic

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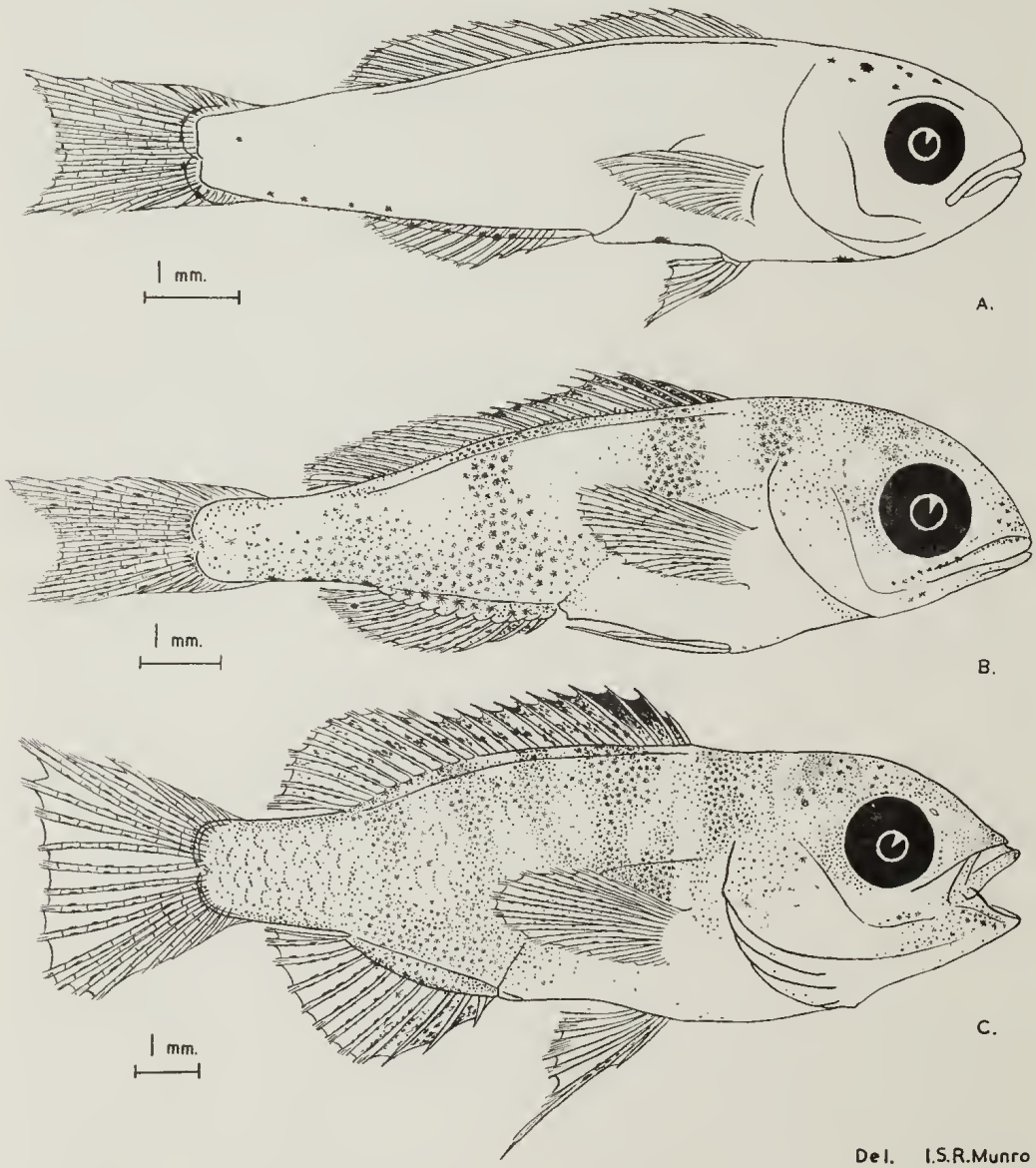
until they attain a length of approximately 12 millimetres. Sueh larvae have been eolleeted in tow nets in the Noosa River during Mareh 1944 and June 1940 and in Bribie Passage (Caloundra) during Mareh 1944. It has been observed in both these estuaries that, upon reaehing this size, these Bream fry leave the plankton and congregate, along with those of the related *Austrosparus sarba* and other species, amongst the *Zostera* weed growth of shallow flats and braekish erecks within a mile or so of the respeetive river mouths. Similar nursery grounds have been observed near the mouths of the Bellinger River, Nambueea River and Lake Macquarie. This ehange of habitat coineides with the first indication of development of sub-adult pigmentation.

Bream larvae and postlarvae smaller than 12 millimetres are wholly transparent and are charaeteristieally marked with distinetive series of black chromatophores. There is probably some yellowish pigment, but this has not been observed in the formalin preserved speeimens used in the present study. In a typical planktonie postlarva of length 10·5 millimetres as is illustrated in text fig. 1A, the blaek ehromatophores form three series, namely: a cluster on the postero-dorsal aspect of the head; a longitudinal series following the ventral margin of the eaudal somites, mainly at the bases of the anal and caudal fins; an internal cluster lining the visceral eavity postero-dorsally. In postlarvae of this size, the head length is approximately 4 and the greatest body height 4½ in the total body length. The eye diameter is slightly greater than the snout length and is 3 in the head length.

The smallest Bream collected in the seine net measured 12·5 millimetres and is illustrated in text fig. 1B. Its pigmentation indieates the beginning of the transition from planktonic to littoral habitat. The sparse blaek pigmentation characteristic of planktonie faeies is being masked by a proliferation of chromatophores constituting the rudiments of a pattern of light and dark banding whieh is destined to persist throughout the first year of life. The nature of this ehange is parallel to that shown to take place in various Mediterranean speeies of Sparidae by Ranzi (1933) and in the Ameriean Seup by Kuntz and Radeliffe (1917). Bream postlarvae of 12 millimetres and over show a progressive development of blaekish brown V-shaped vertieal bands on the dorsal half of the body, superimposed upon a general ground eoloration of greenish bronze. About six or eight of these bands appear and they are alternately broad and narrow. Small Bream differ from small Tarwhine (*A. sarba*) in the pattern of banding, the latter speeies possessing five or six approximately equal and broader bands whieh extend ventrally below the level of the mid-line. The eephalic series of black chromatophores of the planktonie postlarvae are substituted by paired clusters overlying the hind brain on the postero-dorsal region of the head. These are eharaeteristie in that they are relatively less distinct than those of the Tarwhine. At 16·0 millimetres the first rudiments of seales are notieeable, eaeh scale being outlined on its ctenoid margin by a semi-eirele of pigment dots. These are notieeable in the eaudal region of the speeimen depicted in text fig. 1C. At 18·0 millimetres a eomplete coat of seales is diseernible. At this stage of development the lateral line is marked off by its relatively darker pigmentation. Inerease of brownish pigment on the seales gives the appearance of a parallel series of longitudinal brownish

stripes both above and below the lateral line, in postlarvae a trifle larger. These extend ventrally to the level of the mid-line and are part of the adult pigmentation. The intensely black margin of the spinous dorsal fin and of its membrane in the region of the first few spines serves further to distinguish young Bream from those of Tarwhine, which have a much lighter pigmentation on the dorsal fin membrane.



Text-fig. 1.—Post-larvae of Australian Bream, *Acanthopagrus australis* (Günther).
A.—From a specimen 10.5 mm. long.
B.—From a specimen 12.5 mm. long.
C.—From a specimen 16.1 mm. long.

At a length of 12 to 16 millimetres the body depth has increased in proportion and is approximately equal to the head length, which is $3\frac{1}{2}$ to $3\frac{2}{3}$ in the total length. In adults the head length decreases to about $4\frac{1}{2}$ and the body height increases to $2\frac{2}{3}$ in the total length. The eye diameter decreases from 3 to $3\frac{1}{4}$ in the head length during growth from 12 to 16 millimetres.

Specific diagnosis was arrived at by following through changes in proportions and pigmentation in a very complete series of many score of specimens of intermediate sizes ranging from planktonic larvae to adults. Possession of the average fin formula of D. XII, 11; A. III, 8-9 separates these young from those of *A. sarba*.

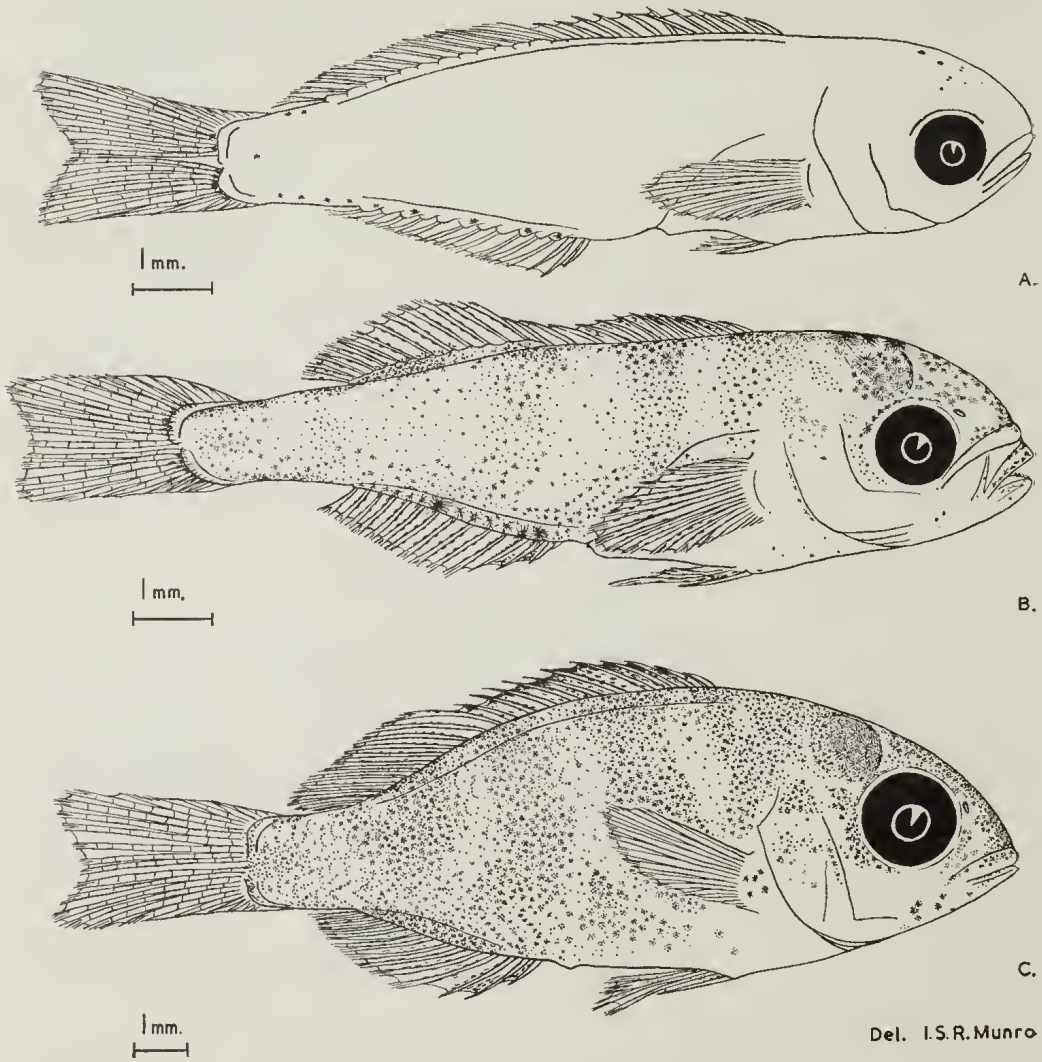
2. AUSTROSPARUS SARBA (Forskål). TARWHINE.

Sparus sarba Forskål (1775), p. 31.

Review of the literature dealing with the Tarwhine, *Austrosparus sarba* (Forskal) reveals that little direct observation has been made in respect to its spawning season. Roughley (1916) indicates that it occurs during early summer. The eggs and larvae are entirely unknown. The writer has noticed that postlarvae, identifiable by their fin counts as being this species, occurred simultaneously with those of the Bream (*A. australis*) in the Noosa River plankton during June 1940. Also, larger postlarvae occur simultaneously with those of *A. australis* in the weedy shallows and creeks near the mouths of Noosa River, Bribie Passage and other east coast estuaries. This evidence rather suggests that both these Sparid species spawn during the same extended season, which in southern Queensland during 1944 was the winter months.

Several postlarvae, varying in size from 11·0 to 12·4 millimetres, have been obtained in the Noosa River plankton in June 1940, and another specimen 11·5 millimetres long was taken in a surface plankton haul at Caloundra on 12/11/44. The smallest postlarval Tarwhine collected with the seine net also measured 11·5 millimetres and was taken in shallow water in the creek joining Weyba Lagoon to Noosa River on 25/6/44. All of these postlarvae have the typical planktonic facies indicated in text fig. 2A. At this stage of development they closely resemble in appearance postlarval *A. australis* of similar size. Their distinctive fin formula, namely D. XII, 13; A. III, 11 which is two or three rays greater in both soft dorsal and anal fin counts than *A. australis,* is the most reliable clue to their diagnosis. These postlarvae are quite transparent and their black pigment is arranged similarly to that of *A. australis* at the same stage of development. The ventral linear series that extends from the anus to the base of the caudal fin is practically identical. The chromatophores of the head are smaller in size and fewer in number and do not extend as far back behind the eye as those of Bream. There is an internal lining of dark cells on the dorsal surface of the visceral cavity and an internal longitudinal series situated dorsally to the vertebral column and extending from the perpendicular at the anus backwards to the base of the tail. The head is shorter than that of the Bream, being $4\frac{1}{4}$ to $4\frac{1}{2}$, and the greatest body height $4\frac{3}{4}$ in the total length. The eye diameter is similarly about 3 in the head length, but the perpendicular measurement between the upper margin of the eye and the top of the head is much greater in *A. sarba* at this stage.

As soon as the postlarval Tarwhine leave the plankton (11·5 to 12·5 millimetres) and frequent the weedy shallows and creeks near the mouths of rivers, their pigment begins to change in pattern and coloration more adapted to the new surroundings. As in *A. australis* and other Sparidae of which the postlarvae are known, this change consists in the development of vertical light and dark banding. Like *A. australis* the ground colour is a greenish bronze and the superimposed banding is blackish. There are five or six equally broad bars interspaced with lighter areas of approximately similar width. These bands are broader and straighter than those of the Bream and extend downwards across the flanks fading away near the ventral margins. Two stages illustrating



Text-fig. 2.—Post-larvae of Tarwhine, *Austrosparus sarba* (Forskal).

A.—From a specimen 12.4 mm. long.

B.—From a specimen 12.8 mm. long.

C.—From a specimen 17.8 mm. long.

the progressive development of this pattern are shown in text figs. 2B and 2C. There is a rapid early change in the head pigment. The chromatophores overlying the brain greatly increase in size and number and form intensely dark rounded patches, one on either side of the head behind the eyes. These are more obvious than in *A. australis*. The spinous dorsal fin membrane receives some black pigment when a size of about 18·0 millimetres is attained but is not so intense as in the Bream. Also at this stage of development scales are apparent. The lateral line is discernible at 20·0 millimetres. During the subsequent ten millimetres growth the rows of scales become visible macroscopically, outlined as longitudinal parallel bands of a brownish colour. These develop into the characteristic longitudinal golden bands of adults, there being six or seven above the lateral line and considerably more below it. Postlarval Tarwhine less than 18·0 millimetres in length have been collected at Caloundra as early as June and in the Noosa River as late as October.

Text fig. 2 indicates how the body proportions alter greatly early in postlarval life. At a size of 18·0 millimetres the body height has exceeded the head length, which has increased to $3\frac{1}{2}$ in the total length. The eye remains conspicuously large. At a length of 30·0 millimetres the steepness of the snout is most noticeable when the head is viewed in profile.

A comprehensive series of stages constituting a complete range of intermediate sizes from planktonic postlarvae to adults form the basis of this description.

3. PELATES SEXLINEATUS (Quoy & Gaimard). TRUMPETER PERCH.

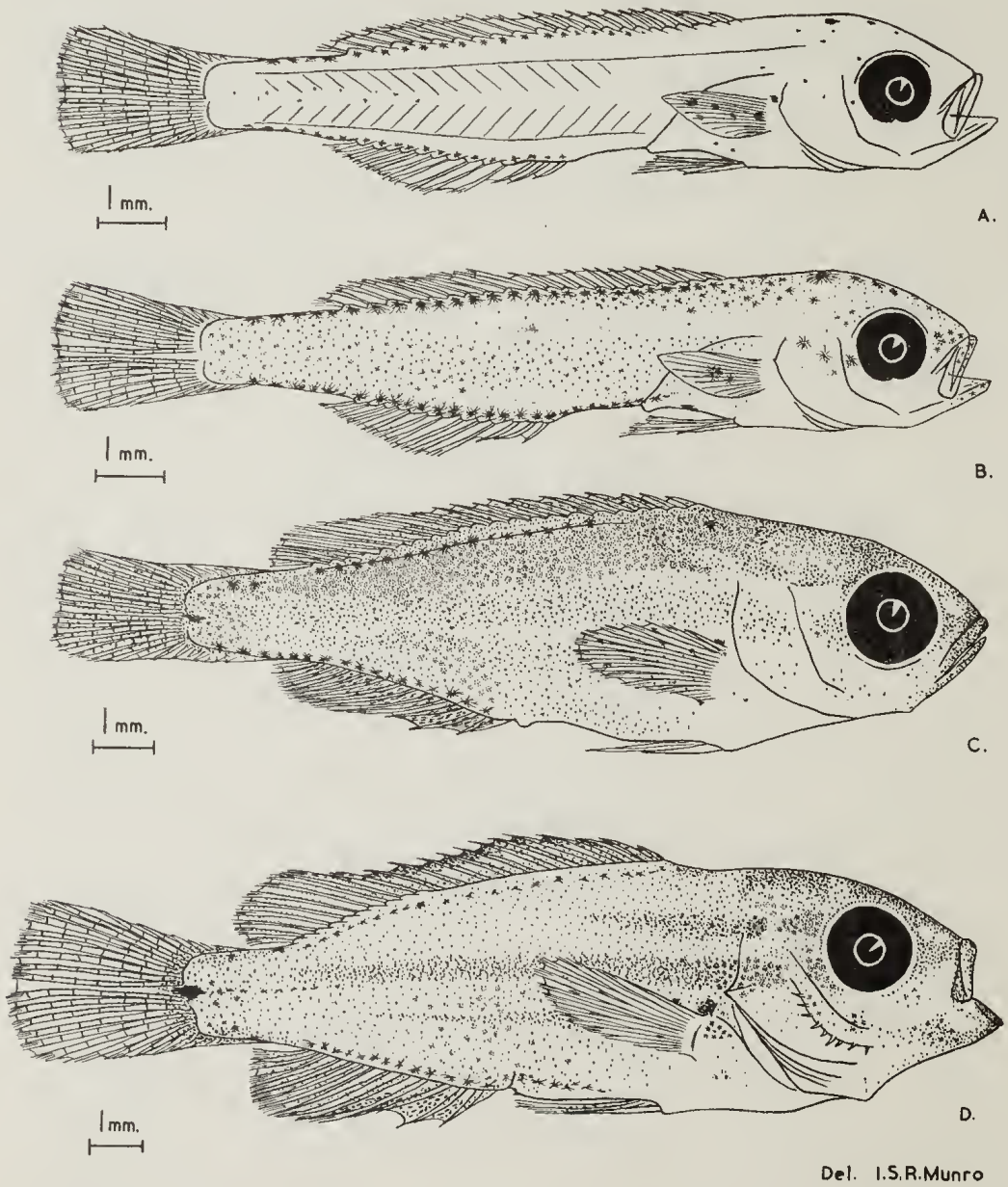
Pristipoma sexlineatus Quoy & Gaimard (1824), p. 320.

Pelates quadrilineatus Cuvier & Valenciennes (1829), p. 146, pl. lv.

A third type of planktonic postlarva with facies generally resembling those of postlarval *A. australis* and *A. sarba* has been collected in tow nets, both in the Noosa River and Bribie Passage estuaries. Two specimens (8·4 mm.) were obtained in March 1944 near the Bribie Passage (Caloundra) entrance and a further four specimens (5·5, 10·5, 11·0 mm.) in the Noosa River during the following month. Others (12·9 to 13·6 mm.) were obtained in the same locality during June 1940. Another (13·5 mm.) was collected in the Noosa River plankton as late as October in 1944 and on the previous day (13/10/44) three other individuals (11·2 to 12·6 mm.) were caught in a dip net at Tewantin township, several miles upstream. The latter were amongst a school of small postlarval *Ambassis jacksoniensis* which were working in close to the bank.

These postlarvae have been identified as those of the common little Trumpeter Perch, *Pelates sexlineatus* (Q. & G.) which is invariably present during most months of the year amongst weed growing in the shallows of most east coast estuaries. The October planktonic postlarvae illustrated in text fig. 3B (13·5 mm.), by virtue of its possession of an intermediate pigment pattern, links up between the younger planktonic postlarva (text fig. 3A) and the tiny recognisable juveniles of this species that frequent the *Zostera* beds in sheltered places. The fin formula D. XII, 10; A. III, 10; P. 15, characteristic of this species and possessed by these planktonic postlarvae gives the necessary confirmation to the diagnosis.

The spawning habits and the characteristics of the eggs and early larvae of *P. sexlineatus* are unknown, except what can be deduced from the above collection data, namely that the spawning season is an extended one, presumably beginning in late summer and lasting until well into the winter. As the localities of collection of postlarval *P. sexlineatus* are the same as those of



Text-fig. 3.—Post-larvae of Trumpeter Perch, *Pelates sexlineatus* (Quoy & Gaimard).

A. and B.—From specimens 13.5 mm. long.

C.—From a specimen 15.0 mm. long.

D.—From a specimen 18.5 mm. long.

other species of which the spawning habit is known, e.g. *Acanthopagrus australis* and *Ambassis jacksoniensis*, it might be deduced that the spawning grounds are the same as for these species, namely close to river mouths. The eggs are probably pelagic.

Planktonic postlarvae are quite transparent and have two prominent series of black chromatophores. One of these is a dorsal series along the bases of the dorsal fins extending back to the caudal peduncle. The other series is ventral and extends from the base of the first anal fin-spine to the caudal peduncle. There are a few scattered cells on the head and an internal cluster lining the visceral cavity. The visceral mass is also heavily pigmented with other colours which fade when preserved in formalin. The body is rather slimmer than that of the Sparidae described above and the head is likewise not as deep and the snout more pointed. The head length is about 4 and the greatest body height 6 in the total length. The eye is approximately 3 in the head length and still possesses a slight ventral depression which is the choroid fissure.

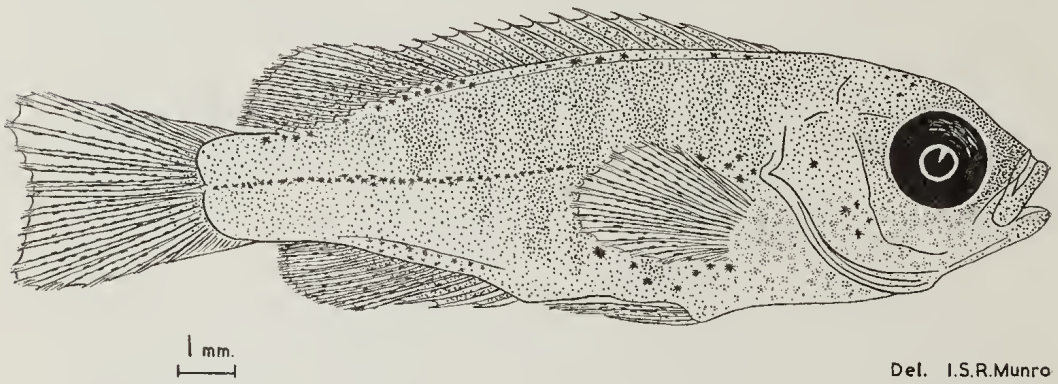
It appears that postlarval *P. sexlineatus* leave the plankton when growth to a length of approximately 13·0 or 14·0 millimetres has been attained. They then begin to frequent the sheltered weedy shallows along with the fry of several other common estuarine species.

As in the Sparidae there are similar adaptive changes in body pigmentation coinciding with the adoption of a littoral habit. In *P. sexlineatus* this is a longitudinal brownish banding on a greenish ground colour. Text figs. 3B to 3D show this change of pigmentation on individuals possessing respective lengths of 13·5, 15·0 and 18·8 millimetres. The older postlarvae shown in text figs. 3C and 3D were both collected in June when using the seine net in a shallow creek at the north end of Bribie Island. The longitudinal bands which increase eventually to six in number are first developed more distinctly on the head and anterior trunk regions. The series of black cells characteristic of the planktonic stages persist temporarily as a secondary pigmentation but disappear at a length of 25·0 to 30·0 millimetres. These chromatophores are greatly enlarged and spider-like in form. There is a single chromatophore of this type at the base of each dorsal and anal fin-spine and fin-ray and others on the caudal peduncle and on the ventral margin of the gut region. This series is most noticeable in the planktonic stage shown in text fig. 3B but the chromatophores decrease in relative dimensions as the fish grows larger. A large black irregularly shaped spot located centrally at the base of the caudal fin is a prominent feature of all immature trumpeters. It is noticeable first at about 15·0 millimetres. Postlarvae of this size also have some development of dark pigment cells on the membranes of the dorsal and anal fins. The head length in juveniles of 15·0 to 19·0 millimetres has increased to about $3\frac{2}{3}$ or $3\frac{1}{2}$ in the total length and the body height has increased similarly to approximately the same proportion. The first indication of the presence of scales is to be noticed in postlarvae 18·5 millimetres long, especially along the lateral banding where the margin of each scale is outlined by a tiny semi-circle of blackish pigment cells. The preopercular spines are also evident in postlarval *P. sexlineatus* of this size.

4. GIRELLA TRICUSPIDATA (Quoy & Gaimard). **BLACKFISH.**

Box tricuspidatus Quoy & Gaimard (1824), p. 296.

Blackfish, *Girella tricuspidata* (Q. & G.) as small as two inches long are to be found commonly in most estuaries of the east Australian coast, when netting amongst weed. Interest lies in the fact that smaller postlarvae of this species can easily be mistaken macroscopically for the young of our Sparidae, particularly Bream. Two small specimens, measuring respectively 15·0 and 17·6 millimetres were obtained in the seine net in the Nambucca River on 19/10/44. The larger of these is illustrated in text fig. 4. In general shape it superficially resembles postlarval *Acanthopagrus australis* of similar size (compare text fig. 1C). It can be distinguished at once by a distinctive fin formula which is usually D. XV, 12; A. III, 12 but in the specimen figured



Text-fig. 4.—Post-larval Blackfish, *Girella tricuspidata* (Quoy & Gaimard). From a specimen 17.6 mm. long.

is D. XIV, 13; A. III, 12. The colour is brownish olivaceous and there are about seven darker vertical bands on the back. There is a secondary series of jet black chromatophores which apparently persist from planktonic stages. There is one linear series of these along the bases of the dorsal fin-rays and fin-spines, and another less distinct ventral series along the bases of the anal fin-rays. There are a few such cells on the head and operculum and a very prominent large cluster on the visceral region directly behind the origin of the pectoral fin and largely hidden by it. A very prominent linear series extends from the centre of the base of the caudal fin, along the mid-line of each side of the body, to the posterior margin of the pectoral fin. The head length and body height are approximately equal and both slightly less than 4 in the body length. The eye diameter is approximately $2\frac{2}{3}$ in the head length.

5. SILLAGO CILIATA Cuvier & Valenciennes. **SAND WHITING.**

Sillago ciliata Cuvier & Valenciennes (1829), p. 415.

Tosh (1902) has already described in detail the eggs and early larvae of the common Sand Whiting, *S. ciliata* Cuv. & Val. which he refers to in his account as *S. bassensis* Cuv. & Val. His material includes no larval stages greater in size than 2·5 millimetres. Tow nettings in the Noosa River during

1944 have produced planktonic stages comparable in development to those described by Tosh. In addition, this source yielded many postlarvae intermediate in size and development between these and the smallest fry that have been seine netted in the sandy shallows of the same estuary. A selected series of such stages is depicted in text fig. 5 and is of partieular interest in exhibiting development of the fin-rays and the transition of pigmentation from the simple larval pattern to the dorsal blotching, characteristic of the younger age-groups of this species.

According to Tosh (1902) the spawning season in Moreton Bay (Southport) is September to February. Larvae and postlarvae ranging in size from 1·5 to 8·0 millimetres and reeognisable as those of *S. ciliata* appeared in the Noosa River plankton first in September. Slightly larger planktonic postlarvae (11·0 mm.) were taken in October and again in December. The smallest Sand Whiting caught in the seine net measured 15·5 millimetres. Postlarvae of sizes less than 20·0 millimetres have been seined at Caloundra and Noosa River in June, September, October, November and January. Fry measuring 30·0 millimetres have been colleeted similarly from April onwards. Apparently the spawning period is an extended one, but the planktonic phase appears to be restricted mainly to early summer and for each individual it terminates when a size of about 15·5 millimetres has been reached.

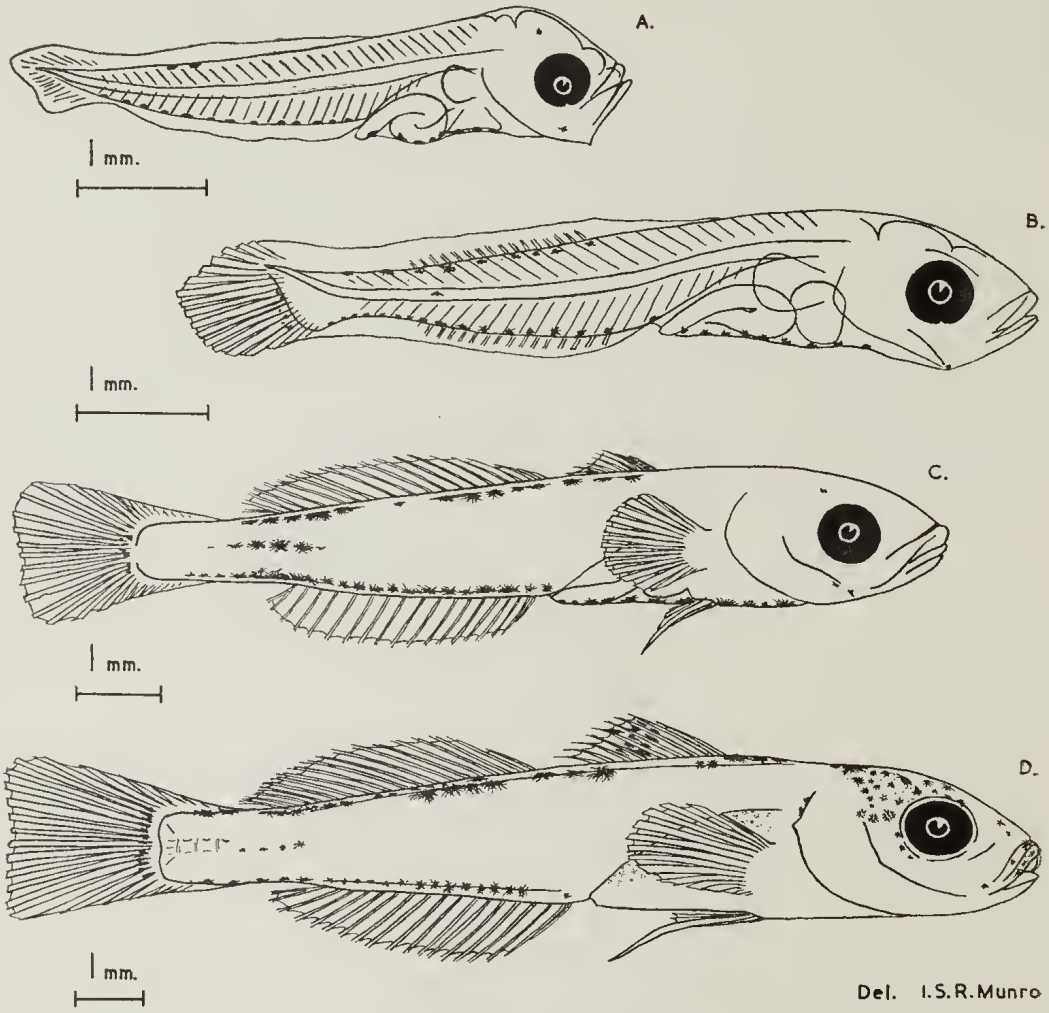
Planktonic larvae less than 5·0 millimetres in size (text fig. 5A), although possessing a well-developed mouth and with complete absorption of the yolk material, have yet to differentiate their fin rays. The black pigment is arranged in a single ventral series extending from the region of the heart posteriorly to the tail region. There are usually about eight cells anterior to the anus and rather less chromatophores than caudal myotomes in the post-anal region. There are one or two isolated cells on the dorsal border of the caudal region.

In larvae of 6·5 millimetres (text fig. 5B) the rudiments of the rays of the dorsal, anal and caudal fins are well differentiated. The black chromatophores of the ventral series persist from earlier stages but the dorsal series has inereased in number and extends further forward basally along the second dorsal fin.

At 10·5 millimetres (text fig. 5C) all fins and their radial components are well defined. The number of rays are easily counted, making it possible to identify these larvae speeifically as *S. ciliata* rather than *S. maculata*. They possess the characteristic modal fin formula: D. XI. I, 17; A. I, 18; P. 15. The black chromatophores are greatly enlarged and stellate. The ventral series still persists along the gut and extends past the anus along the ventral border of the caudal somites. There is a large chromatophore at the base of each anal fin-ray. The dorsal series is restricted to the areas at the bases of the fins and the chromatophores have inereased in number and are arranged in groups. A third series has made its appearance along the mid-line of each side of the body. These post-larvae are still planktonie.

Upon reaching a size of 15·5 millimetres (text fig. 5D), namely the stage when the habit is altered from planktonic to littoral, the tiny Sand Whiting begins to aequire the shape and general facies of the adults of its speeies and

is readily recognisable as such. The ventral chromatophore series is now restricted to the base of the anal fin. The dorsal series extends further forward than previously and is grouped in several clusters. Small stellate cells covering the brain are visible through the transparent dorsal surface of the head above



Text-fig. 5.—Larvae and Post-larvae of Sand Whiting, *Sillago ciliata* Cuv. & Val.
A.—From a specimen 5.0 mm. long.
B.—From a specimen 6.5 mm. long.
C.—From a specimen 10.8 mm. long.
D.—From a specimen 15.5 mm. long.

the eyes. Similar cells lining the visceral cavity can also be seen through the body tissues and there are several sub-surface groups along the mid-line of each side of the body. Additional surface cells can now be seen at the base of the caudal fin and on the head, particularly around the lips. Rows of black ovate cells which are the rudiments of the oblique banding across the spinous dorsal

fin have appeared on the membrane of that fin. The elongate, bifurcid first soft ray of the ventral paired fins is a noticeable character of postlarvae of this size and larger.

Postlarvae, when leaving the plankton, have body proportions somewhat similar to adults, namely with head length 4 in the total length and the greatest body height $\frac{2}{3}$ that of the head length. The head length to body height proportion varies little with increase in age, but the head length increases to about $3\frac{1}{2}$ in the total length by the time maturity is reached.

At Caloundra and Noosa River this species is to be found during all months of the year; individuals smaller than 90 millimetres abounding in small schools in the shallows, mainly over sand. All characteristically possess dark markings on the dorsal half of the body. In fry of 15·0 to 20·0 millimetres there are two rows of about eight rounded clusters of brownish black chromatophores forming blotches, one series along the dorsal margin and the other along the mid-line of each side. At 30·0 millimetres these have fused and form irregular bands on the upper half of the body, each pointing obliquely downwards and forwards. According to Ogilby (1893) these markings are characteristic of the young of both *S. ciliata* and *S. maculata*, but persist in the adult stages of the latter species only. The black spot at the base of the pectoral fin is not developed until late in the first year of life.

6. ICHTHYSCOPUS LEBECK (Bl. & Schn.). **QUFENSLAND STARGAZER.**

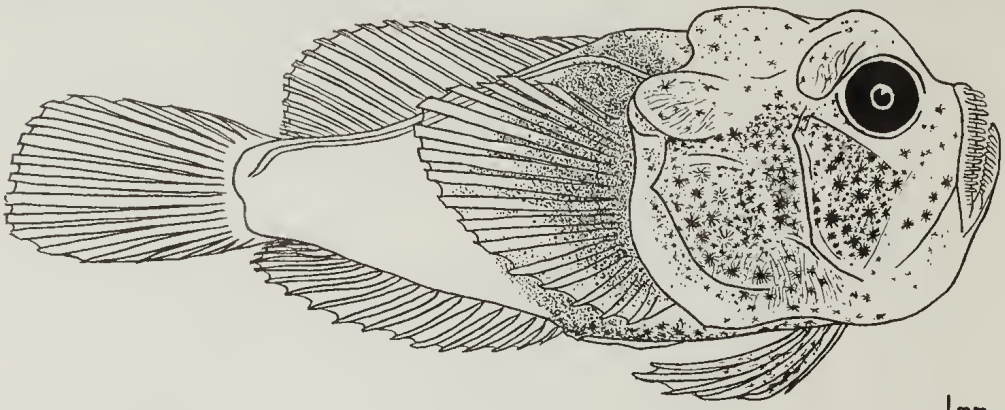
Uranoscopus le Beck Bloch and Schneider (1801), p. 47.

Uranoscopus inermis Cuvier and Valenciennes (1829), p. 310, pl. lxvi.

Adults of this extraordinary species have always been objects of special interest because of their unusual shape and habit. The present note concerns a single postlarval specimen of 15·4 millimetres length. This was captured in the fine meshed seine net in the sandy shallows near the mouth of the Noosa River on the 13th of October, 1944. This postlarva is sufficiently advanced in development to be readily identified as the common Stargazer of the Queensland coast, known to authors as *Ichthyscopus lebeck* (Bl. & Schn.). Although Whitley (1936) has proposed the specific name *sannio* for this Australian form, the present writer has found insufficient justification for this separation after comparing the adult specimens in the Queensland Museum collection with the descriptions of Indian material by Cuvier and Valenciennes (1829) and Day (1876).

This postlarva, illustrated in text fig. 6, differs somewhat from adults of the species both in proportions and coloration. The fin formula is D. ?, 18; A. 17; P. 17; V. I, 5, which agrees closely with those of adult specimens in the Queensland Museum collection. The eye diameter is relatively large as compared with the head length and the eyes are placed dorso-ventrally instead of dorsally as in adults. The migration of the eyes, from a lateral position in larvae to the dorsal aspect of the head of adults, by disproportionate growth of the skull bones has been observed also in related forms, namely the American *Astroscopus guttatus* by Pearson (1941) and the Mediterranean *Uranoscopus scaber* by Salfi (1933). The mouth with its characteristic labial fringes has already become vertical. The exposed bony cheek plates are discernible as their

respective developing components but differ somewhat in shape from those of adults. The cleithrum bones are, at this stage, bluntly rounded, massive processes on the posterior of the skull. They lack the sharp, internal, bony, spinous projection and its surrounding, fleshy, ventrally fringed, humeral flap



Text-fig. 6. Post-larva of the Stargazer, *Ichthyscopus lebeck* (Bl. & Schn.). From a specimen 15.4 mm. long.

which is a noticeable and unusual structure located above the pectoral fins of adult *Ichthyscopus*. The pectoral fin is relatively larger in postlarvae than in adults.

The pigmentation is totally unlike that of adults. The postlarval body completely lacks the canary yellow ground coloration with its superimposed chocolate brown, reticulate pattern on the dorsal part of the back, and the finer mottling on the head. Posterior to the line joining the origins of the second dorsal and anal fins, the body is quite immaculate as are likewise the soft dorsal, anal and caudal fins. During life, this portion of the body is quite transparent and contrasts with the blackness of the head and the dark band of pigment which surrounds the body in the region between the head and the origins of the soft dorsal and anal fins. The pectoral fin is also darkly pigmented on the rays and membranes, particularly on the basal half. The ventral paired fins are only lightly pigmented. The head pigment is composed mainly of largish stellate cells which are in greatest concentration on the preopercular and subocular regions. The latter is particularly prominent and persists as a large, rounded, dark blotch below the eyes of adult Stargazers. The dark parts of this postlarva had a metallic iridescent sheen when viewed macroscopically in the living condition.

7. SPHEROIDES HAMILTONI (Richardson). COMMON TOADFISH.

Tetrodon hamiltoni Richardson (1846), p. 63, pl. xxxix, f. 10-11.

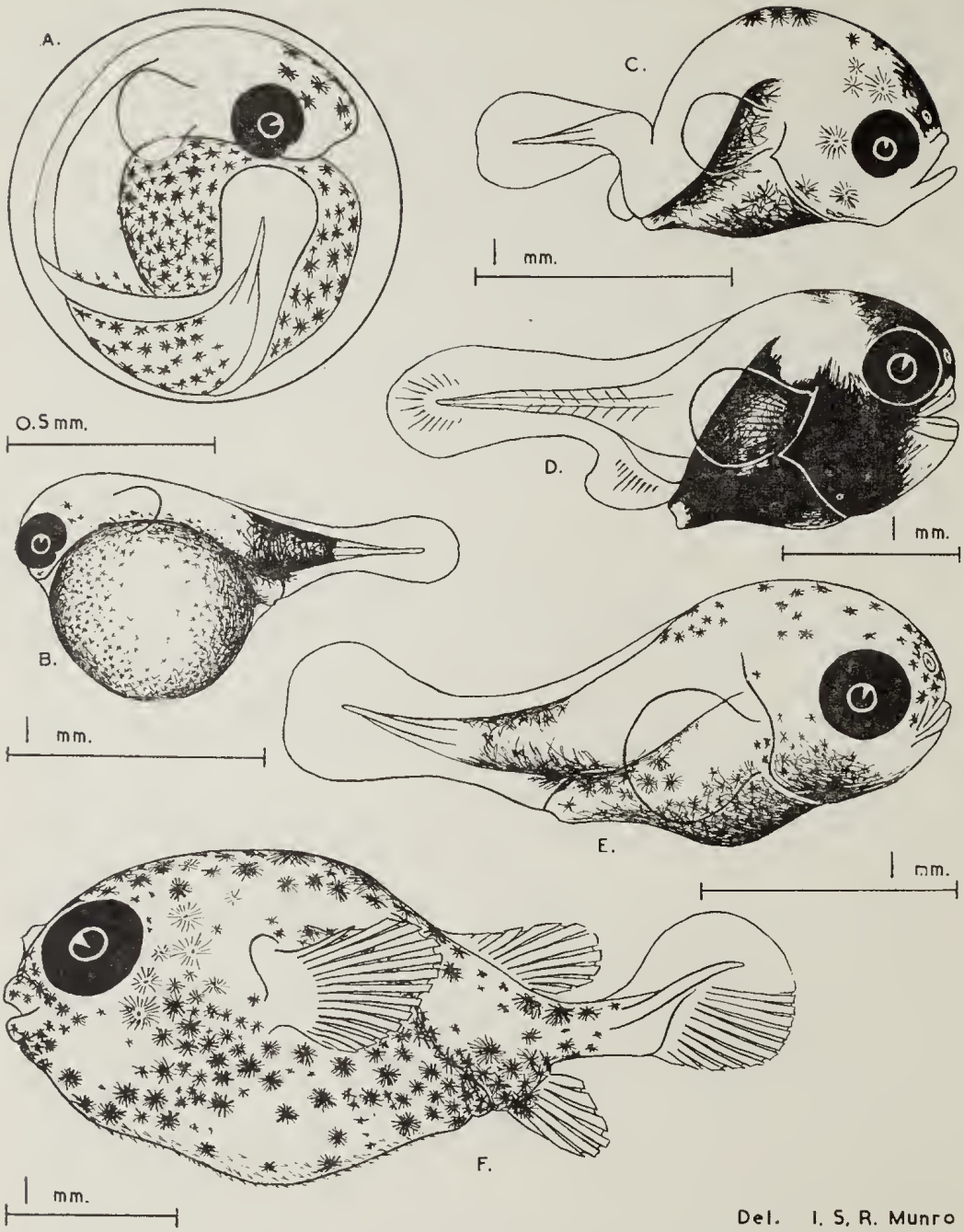
A few larval and postlarval stages, recognisable as belonging to fishes of the Family Tetraodontidae, have been picked up in surface tow nettings near the mouth of the Noosa River, some in June 1940 and others during April, August and September 1944. A few eggs, collected in the same locality in April, had a greyish, rough, thickened outer coating and led the writer to suspect that they were demersal rather than pelagic and had been brought to

the surface by the rip of the ebbing tide. Welsh and Breder (1922) have shown that the related American *S. maculatus* has adherent demersal eggs. The Noosa River eggs measured 0·94 millimetres in diameter and from them hatched larval toadfish which have been identified as our common species *S. hamiltoni*. At first there is a globular yolk-mass underneath the highly pigmented skin of that region which soon becomes the visceral region. The yolk is soon absorbed, and upon attaining a size of 2·0 millimetres a close resemblance to adult facies becomes apparent.

Two distinct types of toadfish larvae have been collected in tow nets and adults of two species, namely *S. hamiltoni* and *S. pleurogramma*, commonly frequent southern Queensland estuaries. These larvae possess complete opercula, which in the adults of this family are reduced to small, rounded apertures situated anteriorly to the pectoral fins. Adult *S. pleurogramma* differs from *S. hamiltoni* in the possession of a prominent spine at the base of the opercular opening. One type of planktonic larva (text figs. 7C and 7D) possess a prominent angular opercular border. The relationship of these larval types to the respective adults is thus evident on the basis of this character alone. The specific identification of these respective larvae was supported further by following through pigmentary changes until a size was reached where adult diagnostic characters were available. There is also correlation between the seasons of occurrence of these respective larval types and the seasons of appearance of small, recognisable postlarvae of both species in the weedy shallows of Noosa River and Bribie Passage. Larvae, identified as those of *S. hamiltoni*, were found in Noosa River plankton collections during April, June, September and October whilst those of *S. pleurogramma* have only been collected in August and September. The former species appears to have a more extended spawning season than the latter.

The larvae of *S. hamiltoni* are approximately 1·6 millimetres in length upon emergence from the egg and are pigmented similarly to the advanced egg-embryo of that species illustrated in text fig. 7A. There is a mass of blackish chromatophores on the frontal region of the head, another mass investing the yolk-sack and a third series forming a lateral patch on either side of the caudal myotomes. The latter group is composed of chromatophores longitudinally arranged in four or five almost parallel rows. There appears to be some slight difference in the pigmentation of the planktonic larvae of this species in respect to the month spawned. Those collected in June 1940 have pigment arranged as above, but when this type have grown to about 2·6 millimetres (text fig. 7E) there is an extension backwards of the head pigment to the level of the origin of the dorsal natatory fold. The scattered, stellate cells of the caudal flanks have become rearranged into dark patches along the dorsal and ventral somite margins, linking across the caudal regions in a diffuse band. The September larvae differ in lacking the caudal pigment completely and there are two patches of dorsal cells, one on the head and the other on the body somites near the origin of the dorsal natatory fold.

A single larger postlarva, 4·6 millimetres in length, was collected in the Noosa River plankton at the surface on the 13th October, 1944. Its pigmentation is composed solely of dispersed, large, stellate, black cells arranged as



Text-fig. 7.—*Spheroides hamiltoni* (Richardson) and *Spheroides pleurogramma* (Regan).

A.—Egg of *S. hamiltoni*, diameter = 0.94 mm.
B.—Newly hatched larva of *S. pleurogramma*, length = 1.7 mm.
C.—Larva of *S. pleurogramma*, length = 2.0 mm.
D.—Advanced larva of *S. pleurogramma*, length = 3.2 mm.
E.—Larva of *S. hamiltoni*, length = 2.6 mm.
F.—Post-larva of *S. hamiltoni*, length = 4.6 mm.

shown in text fig. 7F. At this size the development of the short dermal spines is evident and many can be seen clearly in the belly region. The dorsal, anal and pectoral fin-rays are well defined but all of the caudal rays are not completely differentiated. The fin formula is D. 9; A. 7; P. 15, which is modal for *S. hamiltoni*. The smallest postlarva taken in the seine net measured 8·5 millimetres. It was collected in the creek at the north end of Bribie Island on October 6th., 1944 along with the 10·5 millimetre specimen shown in text fig. 8B. The 8·5 millimetre specimen possessed the ability to inflate itself, as is characteristic of adults of this family. The postlarvae appear to leave the plankton when a length slightly greater than 4·6 millimetres is attained. The larger postlarva shown in text fig. 8B (10·5 mm.) has the body proportions and meristic characters of adult *S. hamiltoni* but its pigmentation is different. The larger, stellate, black chromatophores, that are interspaced with smaller ones on the dorsal surface, apparently represent the rudiments of the adult mottling of large round spots with minute specks in the interstices. The dark lateral stripe, composed of closely packed black chromatophores, presumably represents the rudiment of the series of discontinuous, oval blotches which ornament the flanks of adult toadfish.

8. SPHEROIDES PLEUROGRAMMA (Regan). **GOLD-BANDED TOADFISH.**

Tetrodon pleurogramma Regan (1903), p. 300, pl. xxiv, f. 2.

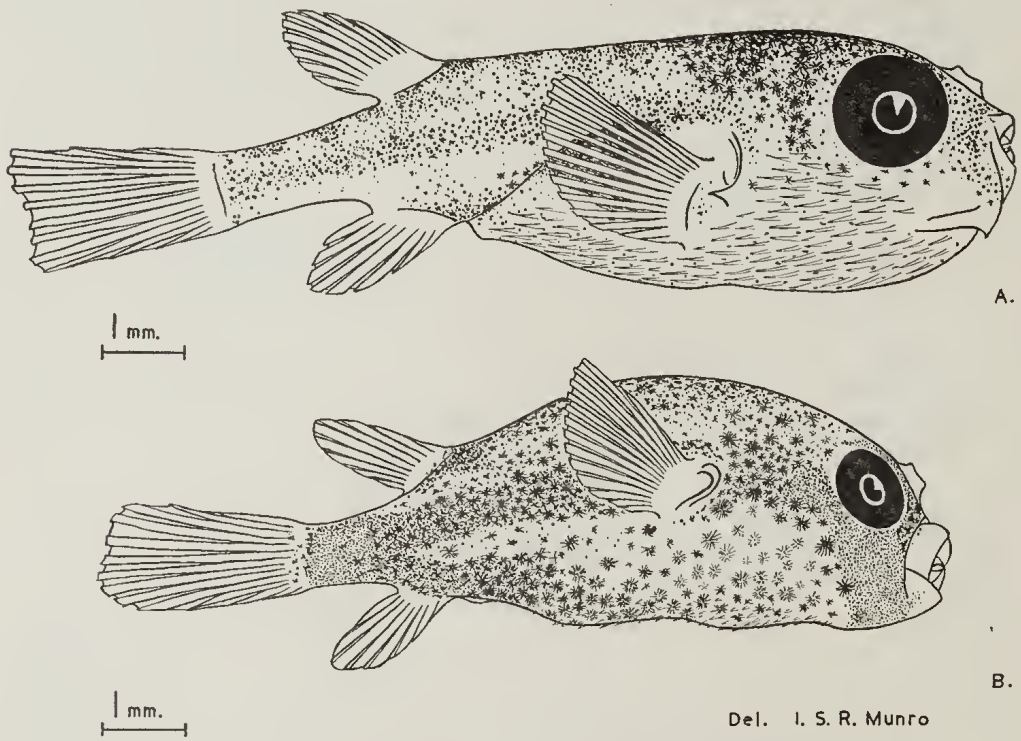
As indicated in the account dealing with the previous species, a few larvae, which, by virtue of their possession of an angular opercular spine can be identified as *Spheroides pleurogramma*, have been collected in the surface plankton of the Noosa River. All these were obtained near the mouth of that river, the first (1·8 mm.) being obtained on 7/8/44 and a further three examples (1·7 to 2·0 mm.) were collected on 17/9/44 together with a similar number identified as the preceding species *S. hamiltoni*. The spawning season appears shorter than that of this other species and is restricted to the late winter months of August and September. No eggs have been seen, but it is thought that they are probably demersal.

A newly hatched larva, measuring 1·7 millimetres in length, was amongst the September collection and is illustrated in text fig. 7B. In shape and size it closely resembles those of *S. hamiltoni* but is very different in its pigmentation. The head is naked except for a few dark cells situated behind the eyes. Instead of several rows of stellate cells, the caudal flank pigment is in the form of an intense, brownish black band formed from the matting together of the fine processes of spider-like cells. The yolk-sack is completely invested with large numbers of very small, stellate, black cells and these are considerably smaller than those of similar disposition in *S. hamiltoni*. Some of these cells extend on to the ventral part of the trunk somites and are particularly intense around the hind-gut.

In older larvae (text figs. 7C and 7D) the prominent band of caudal pigment completely disappears. The stellate cells of the yolk-sack proliferate and form an intensely black pigmentation on the skin adjacent to the visceral cavity. At a length of 2·0 millimetres there appear large, stellate, black cells on the operculum behind the eye and on the snout and back (text fig. 7C). With continued growth to a size of 3·2 millimetres (text fig. 7D) this pigment spreads

and forms an intensely black band which starts at the anus, covers the visceral cavity and the operculum, and extends past the eye on to the nape of the head. Posterior to this band there is no pigment on the body or fins. Also anterior to it is a small, unpigmented area around the maxillary and mandibular regions.

The smallest postlarva collected in the seine net was one of several that were netted on a sandy bottom near the mouth of the Noosa River on October 13th, 1944. It measures 12·5 millimetres and is illustrated in text fig. 8A. The opercular spine is quite prominent and a thick coating of dermal spines, each longer than those of *S. hamiltoni,* is present on the belly and cheek regions. The fin formula is typical of this species, being D. 10; A. 8; P. 15.



Text-fig. 8.—

A.—Post-larval *Spheroides pleurogramma* (Regan). From a specimen 12.5 mm. long.

B.—Post-larval *Spheroides hamiltoni* (Richardson). From a specimen 10.5 mm. long.

The pigmentation pattern already foreshadows that characteristic of adults. The back is covered with large numbers of small, blackish cells arranged in dense groups alternating with more lightly pigmented areas. This dorsal network soon begins to assume the appearance of irregular white spots on a ground of darker brown colour. The dark, longitudinal, side stripe of the adult pattern is already present. The more anterior of the two dark, dorsally transverse cross-bands is present in the form of a thick cluster of large cells above the origins of the pectoral fins. Another concentration of large cells behind the eye precedes the development of the five or six subvertical dark cheek stripes.

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